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(54) A tumor diagnosis apparatus

(57) Apparatus for the diagnosis of malignant tumors relies on variations in optical properties of a blood or plasma sample 35, 42, when measured by irradiating the sample with a visible laser beam both with and without impression 36, 36′, 43, 43′ of a direct-current magnetic field on the said sample. As shown, detector 40 measures reflectivity (determined by refractive index) if sample 35 on a glass slide 34, and detector 45 measures the spread angle of light transmitted by sample 42.

Fig.5

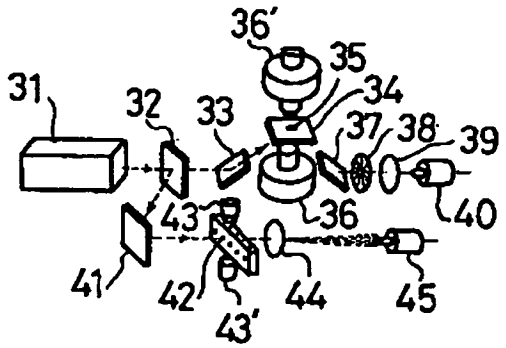

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Fig.1

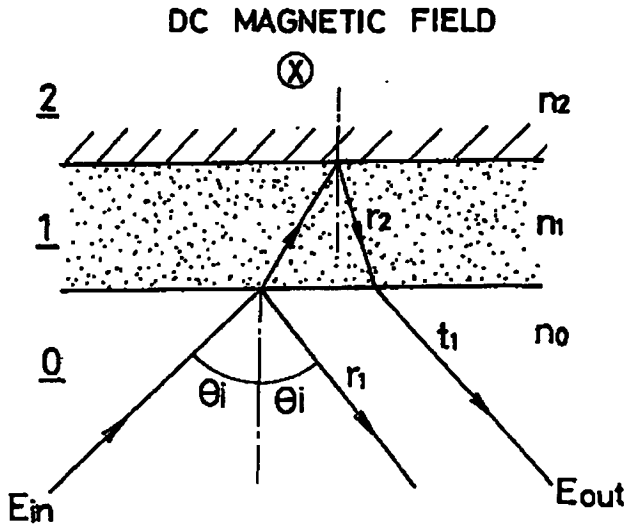

Fig.2

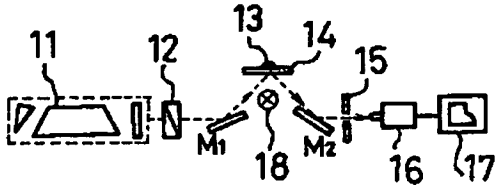

Fig.3

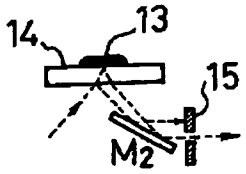

Fig.4

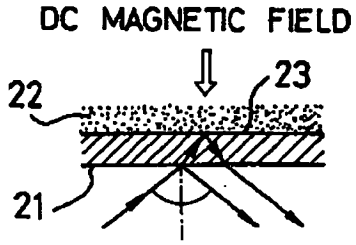

Fig.5

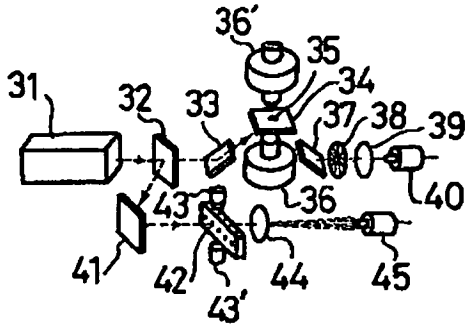

Fig.6

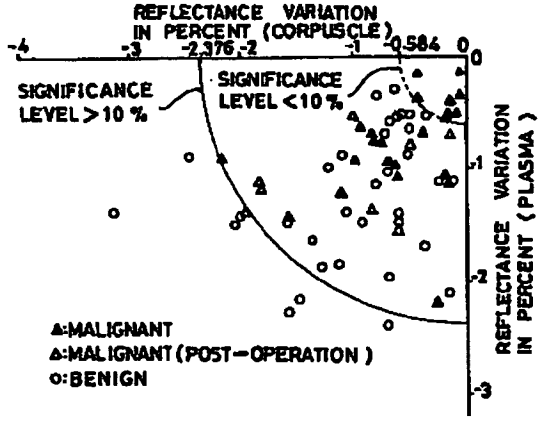

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Fig.7

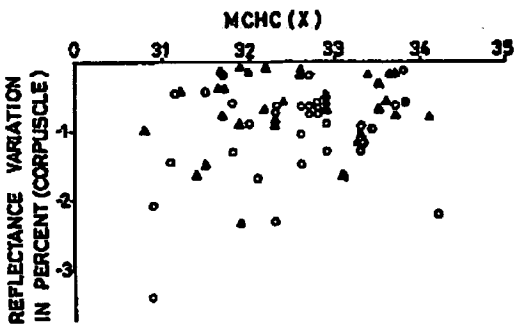


Fig.8

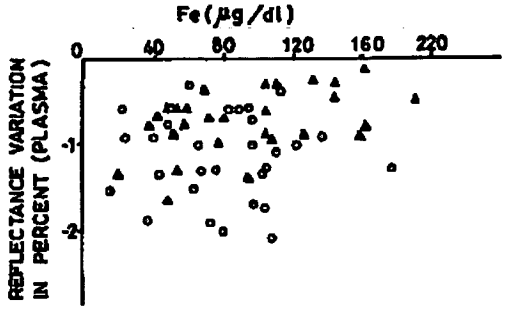


Fig.9

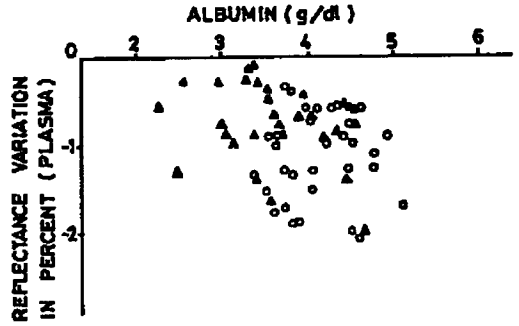


Fig.10

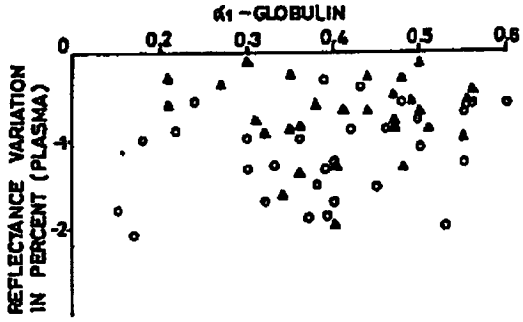


Fig.11

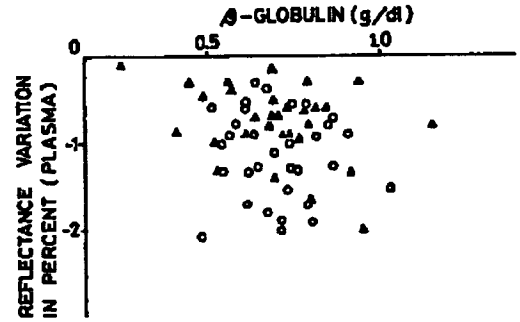


Fig.12

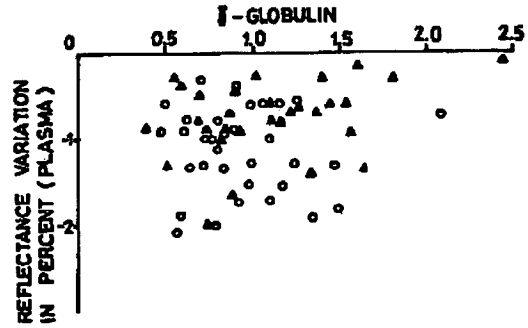


Fig.13

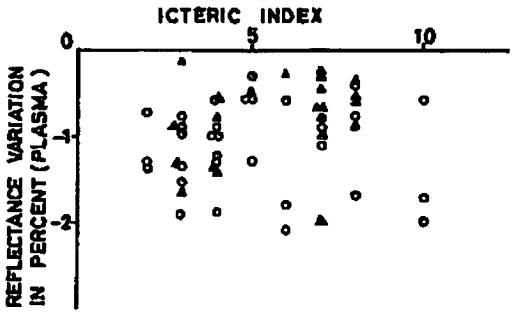


Fig.14

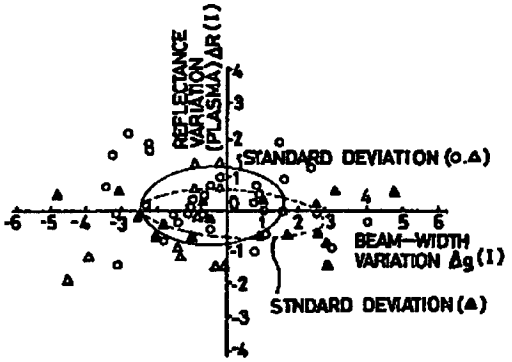


Fig.15

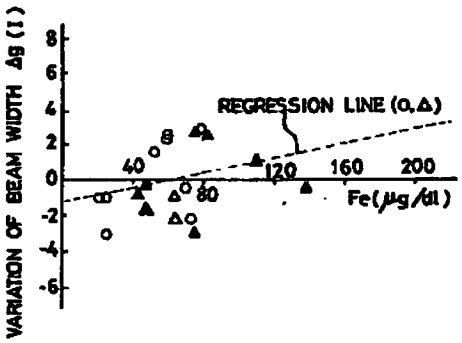


Fig.16

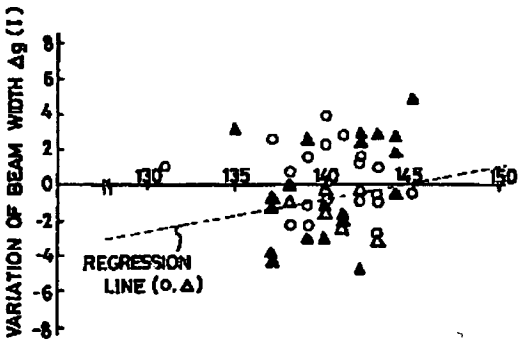


Fig.17

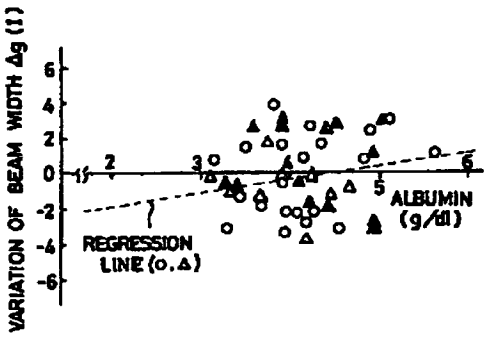


Fig.18

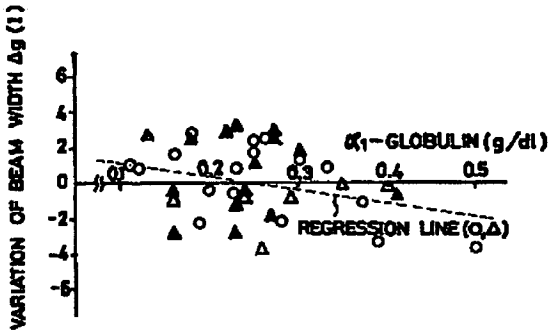


Fig.19

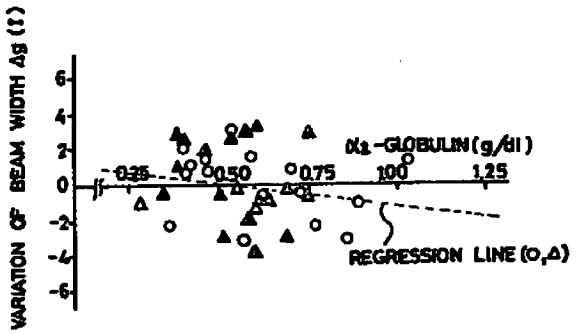
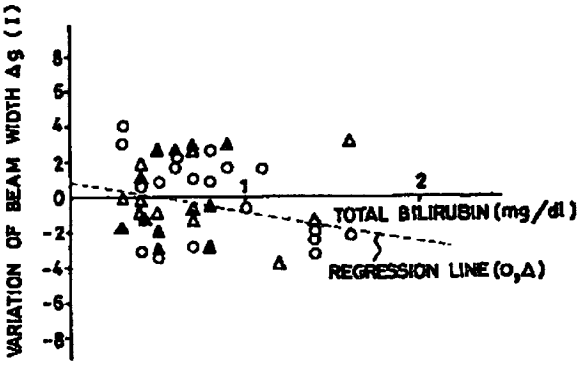


Fig.20



SPECIFICATION

A tumor diagnosis apparatus

The present invention relates to a tumor diagnosis apparatus, by which one can distinguish between benign and malignant tumors, and, in case of malignant tumor, diagnose the progress of the disease, on the basis of results from tests on human blood and human plasma carried out by both magnetic and optical means.

In routine diagnosis, it is very important to distinguish whether a disease is malignant or benign and, if malignant, to known the progress of the disease. For malignant diseases such as carcinosarcoma, evaluation of prognosis or prediction of recuparation after operation is indispensa-ble for clinics. For these purposes, many blood-analysis techniques have recently been developed, both biochemical and immunological, in addition to conventional methods such as X ray and endoscopy. Determination of a disease generally depends mainly on a total evalution by the above, but the perfect solution has not yet achieved.

In the last few years laser systems have been proposed as diagnostic means based upon human blood analysis to sort and measure blood cells. However, the situation of the art can be unfortunately said to be similar.

In the present invention, it is intended to make diagnosis from tests results by newly incorporating an effect of magnetic field into the interaction between laser beam and human blood. The purpose of the present invention is to present a novel apparatus for diagnosis of tumors by combining the optical means based upon the effect of laser beam on human blood with an effect of magnetic field.

In the tumor-diagnostic apparatus of the present invention, human blood and plasma samples collected from patients of various diseases are irradiated with a visible laser beam, especially the argon (Ar) laser beam that has its emitting wavelength near to 0.5 μm and is characterized by its sensitivity against human blood and plasma.

The tumor-diagnostic apparatus of the present invention is composed of a malignant tumor-diagnostic system (hereinafter called System A), wherein laser beam reflectances of human blood or plasma sample with and without impression of magnetic field are measured respectively, and, based upon the reflectance variance ΔR obtained from measured reflectances under both conditions, malignant tumor is diagnosed; and the other malignant tumor-diagnostic system (hereinafter called System B), wherein the spread angles of the laser beam in the human plasma samples under conditions with and without impression of magnetic field are measured, and, based upon the spread angle variance $\Delta\theta$ obtained from measured angles under both conditions, malignant tumor is diagnosed.

System A is, in turn, composed of an optical means to irradiate human blood samples from various diseases with a visible laser beam, e.g. Ar laser beam of wavelength near to 0.5 μm and obtain the reflected beam, and a magnetic means having a dc magnetic field that gives the said reflected beam variance necessary to distinguish malignancy of diseases from benignancy. System B is arranged so that it can measure the spread angles of the laser beam that is transmitted through the human plasma samples under the conditions with and without the magnetic field, respectively, and then diagnose tumors on the basis of the variance of the spread angle due to the existence of magnetic field.

For further explanation, Figs. 1 to 20 and Tables 1 to 3 are referred to.

Figure 1 is a principal diagram for System A.

Figure 2 is an experimental schematic diagram for System A, and Fig. 3 illustrates its main part.

Figure 4 is a principal diagram for System B.

Figure 5 is an experimental schematic diagram for System B.

Figures 6 to 20 are diagrams illustrating the measured with the use of apparatus of the present invention.

Table 1 shows correlations between various parameters of human corpuscle and reflectance variance ΔR.

Table 2 shows correlations between various parameters of human plasma and reflectance variance ΔR.

Table 3 shows data obtained by statistical analysis of correlations between various parameter of human plasma and spread angle variance $\Delta\theta$.

First, a blood sample *2* is dropped on a glass plate *1* as shown in Fig. 1. The refractive indices of the air *0*, glass plate *1*, and sample *2* are given n_0, n_1, and $\tilde{n}_2$ (as a complex index), respectively. When the light intensity E_{in} is incident on the sample *2* placed on the glass plate *1* at the incident angle θ_i, the reflected light intensity E_{out} from the sample *2* is expressed as follows, so far as the reflected light from the first surface of the glass plate is ignored:

$$E_{out} = t_1^2 r_2 E_{in}, \quad (1)$$

where t_1 is the transmittance of the glass plate *1*, and r_2 is the reflectance of the sample *2*.

In general, human blood consists of two major components: plasma and corpuscle. The plasma is usually ionized at more than 97% of content, and also about 10% of the corpuscle content is ionized. Therefore, these ionized particles must predominate in the optical property under the impression of magnetic field. Then these optical refractive indices may have a large wavelength dependence, depending on the characteristics of ions, molecules, and atoms included.

When there is no magnetic field, the refractive index of the blood sample presents an isotropic form given by

$$\tilde{n}_2 = n_2 - ik, \qquad (2)$$

where n_2 and k are the real and imaginary refractive indices, respectively. When a magnetic field is impressed onto the sample, the refractive index may become an anisotropic tensor form with each component n_{ij} as follows, since all charged and ionized particles are influenced by the magnetic field: (Refer to K.G. Budden, Radio Wave in the Ionosphere, Cambridge Univ. Press, London, 1961, page 199.)

$$[\tilde{n}_2] = \begin{bmatrix} \tilde{n}_{xx}, \tilde{n}_{xy}, \tilde{n}_{xz} \\ \tilde{n}_{yx}, \tilde{n}_{yy}, \tilde{n}_{yz} \\ \tilde{n}_{zx}, \tilde{n}_{zy}, \tilde{n}_{zz} \end{bmatrix}. \qquad (3)$$

If the amplitude reflectances of the blood sample, plasma or corpuscle, with and without the impression of magnetic field, are r_2 (H) and r_2 (O), respectively, the reflected intensity variation ΔE_{out} due to the impression is expressed as follows:

$$\Delta E_{out} = t_1^2 E_{in} [r_2(H) - r_2(O)]. \qquad (4)$$

Normalizing this by the reflected light intensity without the impression [i.e., $E_0 = t_1^2 r_2(O) E_{in}$], so the normalized intensity variation Δr is expressed as follows:

$$\Delta r = \frac{\Delta E_{out}}{E_0} = \frac{t_1^2 E_{in} [r_2(H) - r_2(O)]}{t_1^2 (r_0) E_{in}} = \frac{r_2(H) - r_2(O)}{r_2(O)} \qquad (5)$$

Since the intensity reflectance R is defined as $R = |r|^2$, the normalized reflectance variation ΔR is given as follows:

$$\Delta R = [R_2(H) - R_2(O)]/R_2(O), \qquad (6)$$

where R_2 (H) and R_2 (O) are the reflectance with and without the impression of magnetic field, respectively.

Since there should be slight differences of the blood constitution and its particle shape of the sample, corpuscle or plasma, between malignant and benign diseases, their reflectance should be changed by the impression of magnetic field. Therefore, if one determines ΔR of both corpuscle and plasma components, investigates the features of ΔR distribution, and searches statistical correlations between ΔR and various parameters of conventional blood tests, it may be possible to distinguish whether the disease is malignant or benign much more definitely.

In fact, by the experiments carried out on the basis of such thought and with the use of System A according to the present invention, desirable results were obtained as described below.

As the optical source seen in Fig. 2, an Ar-ion laser *11* (NEC 3201) tunable with a Littrow prism was applied.

Since it had been observed in preliminary experiments, that the reflectance variations for both plasma and corpuscle tend to split so much each other according to malignant or benign, at the wavelength of 0.5017 μm among eight possible wavelengths, so this line was used throughout the experiments.

The normally polarized beam, i.e., the electric field component vertical with respect to the plane of incidence, was incident on the glass plate *14* at an incident angle θ of 45° through the attenuator *12* and the mirror M_1. The beam intensity to the blood sample *13* on the glass plate *14* was adjusted to a few milliwatts by the attenuator *12* in order to avoid damaging the sample. Each sample of approximately same amount was dropped on the glass plate *14* of

about 5 mm thick by pipet. The glass plate *14* was cleaned after each measurement, using a hemolytic enzymatic solvent (Amkoa 300).

A dc magnetic field *18* of about 2.5 kOe was impressed vertically on the incidence plane in order to measure the reflectance variation due to the magnetic field. The only reflected beam from the sample *13* was filtered out through the iris *15* placed right after the mirror M_2 (See Fig. 3), received by the detector *16*, and measured and recorded by the recorder *17*. (I.e., reflected beams other than that from the sample were refused admission into the detector *16* as shown in Fig. 3.)

The following description is referred to System B illustrated in Fig. 4 and Fig. 5.

Human plasma has high transmittance all over the region of visible light. However, when visible light of a specific wavelength incident on plasma in a testing cell, the light is scattered with a certain spread angle by plasma component particles. In addition, when a magnetic field is impressed thereon, the spread angle brings out some change, since the impressed plasma becomes predominantly occupied by electrically charged particles such as ions.

On the basis of such thought, in System B of the present invention, a human plasma sample *22* was dropped on the glass plate *21*, and impressed by the magnetic field in the arrow direction shown in Fig. 4. The incidence intensities of the laser beam from the boundary surface *23*, i.e., the second reflective surface, between the sample *22* and the glass plate *21* under the conditions with and without the impression of magnetic field, were determined and defined as I(H) and I(O), respectively. Normalizing the intensity variation ΔI due to the impression, based on of I(O), the reflectance variance ΔR was calculated from the reflectance R(H) with the impression, and the reflectance R(O) without the impression as follows:

$$\Delta R = [R(H)-R(O)]/R(O). \quad (7)$$

On the other hand as already mentioned, when a beam of a specific wavelength is incident on human plasma, the transmitted beam is scattered, and then the spread angle varies according to conditions with and without the impression of magnetic field, similarly to the case of reflectance variation; therefore the spread angle variance $\Delta\theta$ is given as follows:

$$\Delta\theta = [\theta(H)-\theta(O)]/\theta(O), \quad (8)$$

where $\theta(H)$ and $\theta(O)$ are the beam spread angle with and without the impression, respectively, in the whole half-width.

The experiments were carried out using an apparatus illustrated in Fig. 5.

An Ar-ion laser *31* (NEC 3201) tunable with a Littrow prism was used as the optical source, and the wavelength was set at 0.5017 μm. The normally polarized beam, i.e., the electric field component vertical with respect to the plane of incidence, from the laser *31* was incident on the glass plate *34* at an incident angle of 45° through the attenuator (not drawn), beam splitter *32* and mirror *33*. The beam intensity to the sample *35* was adjusted to a few milliwatts by the attenuator in order to avoid damaging the sample. Each sample *35* of approximately same amount was dropped on the glass plate *34* of about 5 mm thick by pipet. Several dozens of glass plate were provided for a series of measurements, and replaced each time in order.

A dc magnetic field is impressed on the sample *35* by the impressing device *36*, *36'*, parallel to the incident plane and vertical to the direction of the beam. The beam reflected by the boundary interface between the sample *35* and the glass plate *34* is reflected by the mirror *37*, filtered out through the iris *38*, enlarged by the lens *39*, received by the detector *40* (GSD-100), and measured, recorded and calculated by the recorder (not drawn).

The main characteristics of System B of the present invention refers to the lower part of Fig. 5. The Ar-ion laser beam of wavelength of 0.5017 μm for example, is split by the beam splitter *32*, reflected by the mirror *41*, and is incident on the plasma cell *42*. On the other hand, the impression device *43*, *43'* is placed opposite to the cell *42* and vertical to the incident beam, and impresses a dc magnetic field on the cell. The transmitted laser beam is enlarged by the lens *44*, and its spread angle is detected by the InAs light-detector *45* with a small opening. The detector *45* is arranged on an automatic stage (not drawn). The whole half-width of the detected angle is measured and recorded by a recorder (not drawn). In this example, a dc magnetic field of 3.0 kOe was impressed by the said magnetic field-impression device.

For testing using System A, blood samples were collected, with adequate medical attention, from patients of malignant or benign disease, and from healthy adults as well, and separated into plasma and corpuscle components. Fig. 6 is a two-dimensional display for reflectance variations ΔR on both components; the ordinate and abscissa refer to the plasma and corpuscle components, respectively. Malignant diseases, benign diseases, and postoperative malignant diseases are marked as ▲, ○, and Δ, respectively.

As a result, all sample marks are in the third quadrant, but the malignant and benign samples tend to split each other; malignant samples ▲ are comparatively near to the origin with smaller

ΔR, while benign samples ○ are comparatively far from the origin with larger ΔR. In addition, many postoperative malignant samples △ tend to be far from the origin. Healthy samples tend to be concentrated in the overlapped region of two major situations, i.e., the critical region. Furthermore, some information can be obtained to warn numerical possibility that the malignant diseases are present with a radius |R| less than 0.485, with a significance level of 10%.

Then, Figs. 7 to 13 show the correlations between ΔR and various parameters in conventional blood tests. When these correlations were statistically analysed using a digital computer for the average index, covariance, regression line, and correlation coefficient, the results shown in Table 1 and Table 2 were obtained for both corpuscle and plasma, respectively.

In Table 1 referred to corpuscle, means concentration of corpuscular hemoglobin (MCHC) shows a high correlation, while number of red blood cells (RBC), amount of hemoglobin (Hb), and hematocrit value (Hct) show some correlation; number of platelets (plat.), number of white blood cells (WBC), mean corpuscular volume (MCV), and mean amount of corpuscular hemoglobin (MCH) do not any correlation.

In Table 2 referred to plasma, iron (Fe), albumin, γ_1-, β-, and γ-globulins, and icteric index show a high correlation, respectively; while sodium (Na), potassium (K), total protein, albumin-globulin ratio (A/G), and α_2-globulin show some correlation, respectively. Chlorine (Cl) and total cholesterol do not any correlation.

Since these correlations are largely dependent on either malignant or benign diseases, they should constitute very effective means to distinguish between malignant and benign diseases.

For testing using System B, the relationships both between the spread angle variation in plasma ($\Delta\theta$) and the reflectance variation of plasma (ΔR), and between $\Delta\theta$ and parameters in plasma tests were investigated, especially with reference to both the combined group of benign diseases and postoperative malignant tumors (hereinafter called benign-postoperative malignant group), and the group of malignant tumors.

Fig. 14 is a two-dimensional display referred to $\Delta\theta$ vs. ΔR for plasma samples. In Fig. 14 (and so forth on Figs. 15 to 20), benign disease, malignant tumor, and postoperative malignant tumor are marked as ○, ▲, and Δ, respectively. According to the findings of Fig. 14, little correlation is found between ΔR and $\Delta\theta$ for the benign-postoperative malignant group ($r = 0.11$, $P = 0.5$), while a negative correlation is found for the malignant tumor group ($r = -0.28$, $P = 0.2$).

Figs. 15 to 20 show correlations between $\Delta\theta$ and parameters of blood tests, only with respect to cases of relatively definite correlation found; Fig. 15 shows the correlation between $\Delta\theta$ and Fe, and Figs. 16 to 20, in turn, those between $\Delta\theta$ and Na, albumin, α_1-globulin, α_2-globulin, and total bilirubin. Table 3 shows the results of statistical analysis on correlations between $\Delta\theta$ and various parameters.

To be summarized, correlations are found between $\Delta\theta$ and parameters including Fe, Na and albumin, with respect to benign-postoperative malignant group, and they also are found between $\Delta\theta$ and parameters including γ_1-, α_2-, and γ-globulins, and total bilirubin with respect to the malignant tumor group. These findings indicate that the diagnosis of malignant tumors may be possible on the basis of the spread angle variance of selected transmitted laser beam through plasma under impression of magnetic field.

Table 1. Correlationships between various parameters and reflectance variation (Corpuscle)

		average		covariance	regression line		correl. coeff.
		index	R (%)		slope (10^{-2})	constant	
RBC	m	409.24	-0.694	-4.145	-0.114	-0.227	-0.130
	b	439.24	-1.264	10.587	0.218	-2.203	0.106
	t	424.24	-0.970	-1.037	-0.024	-0.870	-0.014
Hb	m	12.655	-0.683	-0.110	-4.407	-0.125	-0.133
	b	13.461	-1.260	0.304	6.089	-2.079	0.095
	t	13.058	-0.971	-0.023	-0.594	-0.894	-0.011
Hct	m	38.939	-0.692	-0.370	-1.397	-0.148	-0.137
	b	41.097	-0.966	0.685	1.640	-1.640	0.189
	t	39.984	-0.825	-0.012	-0.034	-0.811	-0.004
WBC	m	6796.9	-0.709	-88.577	-0.0014	-0.611	-0.068
	b	7640.0	-0.959	-66.269	0.0013	-1.056	0.051
	t	7204.8	-0.830	-67.066	-0.0012	-0.746	-0.050
plat.	m	14.609	-0.674	-0.199	-0.606	-0.585	-0.069
	b	17.210	-0.966	0.291	1.656	-1.251	0.124
	t	15.869	-0.816	-0.155	-0.584	-0.723	-0.055
MCV	m	95.724	-0.691	0.103	0.131	-0.816	0.022
	b	91.141	-1.043	-1.325	-0.448	-0.641	-0.109
	t	95.126	-0.892	-0.234	-0.441	-0.466	-0.048
MCH	m	31.142	-0.692	0.103	1.097	-1.034	0.064
	b	30.778	-0.962	0.000	-0.009	-0.959	0.000
	t	30.919	-0.825	0.078	1.180	-1.190	0.054
MCHC	m	32.533	-0.692	0.074	9.942	-3.926	0.163
	b	32.523	-1.043	0.157	21.160	-7.925	0.260
	t	32.529	-0.865	0.114	15.540	-5.919	0.209

(Note) M: malignant, b: benign, t: total

Table 2. Correlationships between various parameters and reflectance variation (Plasma)

		average		covariance	regression line		correl. coeff.
		index	R (%)		slope (10^{-2})	constant	
Fe	m	92.357	-0.742	7.465	0.357	-1.072	+0.442
	b	81.207	-1.148	-0.418	-0.033	-1.121	-0.023
	t	86.684	-0.948	4.542	0.272	-1.158	0.230
Na	m	135.48	-0.784	-0.249	-3.200	3.553	-0.193
	b	136.61	-1.142	-0.034	0.458	-1.768	0.026
	t	136.06	-0.966	-0.197	-2.513	2.454	-0.139
K	m	3.967	-0.788	-0.035	-22.570	0.107	-0.193
	b	4.018	-1.142	0.013	7.630	-1.449	0.065
	t	3.986	-0.974	-0.010	-5.960	-0.736	-0.048
Cl	m	99.655	-0.812	-0.144	-1.622	0.804	-0.107
	b	99.818	-1.142	-0.128	-1.331	0.186	-0.084
	t	99.774	-0.988	-0.137	-1.493	0.501	-0.091
T-protein	m	6.623	-0.762	-0.059	-6.046	-0.362	-0.136
	b	6.861	-1.142	0.030	5.913	-1.548	0.086
	t	6.652	-0.961	-0.053	-3.982	-0.697	-0.091
A/G	m	1.256	-0.771	-0.019	-27.250	-0.429	-0.159
	b	1.468	-1.137	-0.008	-9.675	-0.995	-0.059
	t	1.366	-0.955	-0.035	-40.290	-0.405	-0.239
Albumin	m	3.615	-0.762	-0.070	-17.020	-0.148	-0.248
	b	4.107	-1.142	-0.005	-2.276	-1.049	-0.021
	t	3.873	-0.961	-0.083	-22.850	-0.077	-0.274
α_1 globu.	m	0.4173	-0.762	-0.001	-9.665	-0.722	-0.023
	b	0.4124	-1.113	0.027	147.390	-1.721	0.385
	t	0.4162	-0.946	0.015	96.300	-1.347	0.232
α_2 globu.	m	0.6403	-0.762	-0.011	-19.510	-0.637	-0.106
	b	0.6933	-1.142	0.017	36.180	-1.393	0.160
	t	0.6681	-0.961	-0.002	-3.031	-0.941	-0.014
β globu.	m	0.6963	-0.754	-0.028	-86.540	-0.151	-0.343
	b	0.6936	-1.140	-0.005	-29.850	-0.933	-0.078
	t	0.6949	-0.957	-0.015	-63.980	-0.513	-0.193
γ globu.	m	1.1967	-0.762	0.055	25.850	-1.072	0.270
	b	0.9603	-1.172	-0.002	-1.628	-1.156	-0.012
	t	1.0606	-0.961	0.050	28.240	-1.261	0.235
T-cho.	m	176.17	-0.808	0.878	0.057	-0.908	0.050
	b	166.82	-1.142	-0.096	-0.006	-1.133	-0.005
	t	171.27	-0.983	1.153	0.073	-1.108	0.059
Ict. Index	m	6.208	-0.765	0.584	6.000	-1.137	0.387
	b	5.097	-1.135	-0.085	-1.497	-1.059	-0.071
	t	5.582	-0.973	0.305	4.000	-1.197	0.211

(Note) m: malignant, b: benign, t: total

Table 3. Δθ-ΔR properties of plasma

		average		covariance	regression line		correl. coeff.	P
		index	Δθ (%)		slope (10^{-2})	constant		
Fe	a	80.75	-0.076	13.443	0.014	-1.205	0.219	0.7
	b	56.53	0.158	14.816	0.024	-1.173	0.307	0.3
Na	a	140.60	0.413	0.509	0.078	-10.52	0.086	0.9
	b	140.13	-0.294	1.490	0.184	-26.00	0.253	0.2
Albumin	a	4.254	-0.069	-0.185	-0.570	2.355	-0.112	0.7
	b	4.073	-0.333	0.251	0.739	-3.343	0.207	0.3
α_1-Globulin	a	0.232	0.580	-0.014	-2.853	1.243	-0.087	0.8
	b	0.264	-0.174	-0.064	-7.502	1.803	-0.364	0.1
α_2-Globulin	a	0.572	0.580	0.035	1.533	-0.297	0.100	0.8
	b	0.587	-0.177	-0.079	-2.515	1.300	-0.234	0.3
β-Globulin	a	0.727	0.580	0.058	2.241	-1.048	0.155	0.7
	b	0.674	-0.177	0.021	1.422	-1.135	0.091	0.7
γ-Globulin	a	1.066	0.580	-0.030	-0.344	0.947	-0.044	0.9
	b	0.928	-0.177	-0.112	-1.396	1.118	-0.208	0.4
Total Bilirubin	a	0.914	0.412	0.051	0.065	0.353	0.025	0.9
	b	0.697	0.351	-0.249	-1.667	0.810	-0.309	0.1

(Note) a: malignant, b: benign and postoperative malignant

CLAIMS

1. A tumor-diagnostic apparatus which is characterized by diagnosis of malignant tumors on the basis of various values indicative of the propeties of blood or plasma sample which are measured under the conditions of irradiation of a visible laser beam with and without impression of a direct-current magnetic field on the said sample.

2. The tumor-diagnostic apparatus as set forth in Claim 1, which consists of a malignant tumor-diagnostic system A_1 which, in turn, consists of a glass plate where each blood or plasma sample is placed on its surface, and reflects a visible laser beam incident onto its reverse side from the reverse side of the sample, a detector for detecting the said reflected beam, a recorder for measuring and recording the said detected amount, and the magnetic field-impression device for impressing a direct-current magnetic field on the said sample; and whereby the laser beam reflectance values of the said sample with and without the said impression of magnetic field are detected respectively, and the reflectance variances serviceable to the diagnosis of malignant tumors are determined; and another malignant tumor-diagnostic system B_1, which, in turn consists of a plasma cell capable of transmitting the said visible laser beam, a magnetic field-impression device for impressing a direct-current magnetic field on plasma sample in the cell, a detector for detecting the spread angle of transmitted beam through the plasma in the cell, and a recorder for measuring and recording the whole half-width on the basis of the above detected values; and whereby, beam spread angle variances serviceable to the diagnosis of malignant tumors is determined with and without impression of magnetic field.

3. The tumor-diagnostic apparatus as set forth in Claim 1, wherein the visible laser beam is an argon laser beam.

4. A tumor-diagnostic apparatus substantially as hereinbefore described with reference to Figs. 1 to 3 of the accompanying drawings.

5. A tumor-diagnostic apparatus substantially as hereinbefore described with reference to Figs. 4 and 5 of the accompanying drawings.

6. A tumor-diagnostic apparatus substantially as hereinbefore described with reference to Figs. 6 to 20 of the accompanying drawings.

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